The reactivity of the alkanes

Chemistry | Industrial Chemistry | Petrochemistry

Difficulty level	Group size	Preparation time	Execution time
easy	2	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/638b946923a87a0003a272cb

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Teacher information

Application

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The experimental setup

In general, alkanes show relatively low reactivity. Their C-H and C-C bonds are relatively stable and cannot be easily broken. In addition, unlike most other organic compounds, alkanes also have no functional groups.

In this experiment, the students investigate the reactivity of alkanes in more detail.

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Other teacher information (1/5)

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Prior knowledge

Students should already have a good basic knowledge of alkanes. Furthermore, the students should be able to handle chemicals and a butane or Bunsen burner safely.

Principle

Due to the high binding energy of C-C and C-H bonds, they can only bond with difficulty. In addition, the low polarity of the alkanes offers no bonding points, so that only very high-energy radicals react with alkanes under normal conditions.

Other teacher information (2/5)

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Learning objective

The students should learn that alkanes are inert, they do not react even with strong acids or oxidising agents. The low reactivity of alkanes is based on the high binding energy and the additional less polar C-C and C-H bonds.

Tasks

Examine heptane and paraffin oil for reactivity.

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Other teacher information (3/5)

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Notes on set-up and procedure

Preparations
Prepare soda-alkaline potassium permanganate solution fresh (add 10% sodium carbonate solution to 5% potassium permanganate solution until light purple).

Have the eyewash bottle ready.

Notes on the student experiments
Make sure that the test tubes are only heated at the bottom and only slightly so that the heptane cannot ignite.

Other teacher information (4/5)

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Methodological remarks

The binding energies for C-C bonds $(348\ kJ\ mol^{-1})$ and C-H bonds $(413\ kJ\ mol^{-1})$ are relatively high for non-polar bonds (for comparison Br-Br: $193\ kJ\ mol^{-1}$). They are therefore only bond with difficulty. In addition, due to the low polarity, neither electrophiles nor nucleophiles have a corresponding point of bonding, so that only very energetic radicals react with alkanes under normal conditions.

The sample with potassium permanganate already serves as an introduction to the detection of double bonds (Baeyer's sample).

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Other teacher information (5/5)

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Disposal

Put the contents of the test tubes into the collection container for combustible organic substances.

Safety instructions

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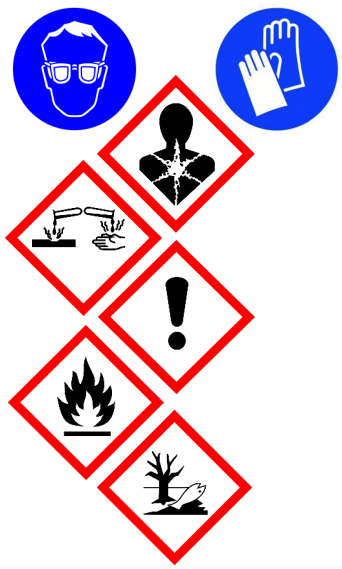

The general instructions for safe experimentation in science lessons apply to this experiment.

For H- and P-phrases please consult the safety data sheet of the respective chemical.

Dangers

- Heptane is highly flammable. When filling, extinguish all open flames, immediately close the bottle after removal and remove it from the workplace!
- Sulphuric acid and nitric acid are highly corrosive. Wash off splashes on the skin immediately with plenty of water!
- Wear protective goggles and gloves!

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Student information

Motivation

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Play bricks made of plastic

Alkanes are the most basic organic compounds and therefore often serve as basic materials in the further processing of many plastics and other organic compounds. Their reactivity plays a major role here, because it must be possible to process these substances as safely as possible and they must also be harmless to the consumer afterwards.

In this experiment, the behaviour of alkanes during further processing via reactions is examined in more detail.

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Tasks

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The experimental setup

Why are alkanes called "saturated" hydrocarbons? hydrocarbons?

Examine heptane and paraffin oil for reactivity.

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Equipment

Position	Material	Item No.	Quantity
1	Test tube, 180x18 mm,100pcs	37658-10	1
2	Test tube brush w. wool tip,d20mm	38762-00	1
3	Test tube rack for 12 tubes, holes d= 22 mm, wood	37686-10	1
4	Test tube holder, up to d 22mm	38823-00	1
5	Laboratory pen, waterproof, black	38711-00	1
6	Rubber stopper, d=22/17 mm, without hole	39255-00	6
7	Protecting glasses, clear glass	39316-00	1
8	Rubber gloves, size M (8), one pair	39323-00	1
9	Pipette with rubber bulb	64701-00	3
10	Potassium permanganate, chem. pur., 250 g	30108-25	1
11	Liquid Indicator pH1-13 UNISOL113	47014-02	1
12	Sodium carbonate, anhyd. 1000 g	30154-70	1
13	Liquid paraffin 1000 ml	30180-70	1
14	Nitric acid 1,40 g/ml, 65%, 500 ml	30213-50	1
15	Sulphuric acid, 95-97%, 500 ml	30219-50	1
16	Water, distilled 5 l	31246-81	1
17	Butane burner with cartridge, 220 g	32180-00	1
18	HEPTANE, NORMAL 1000 ML	31366-70	1

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Set-up (1/2)

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Figure 1

1. Number the test tubes from 1 to 6, place them next to each other in the test tube rack (Fig. 1).

Set-up (2/2)

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2. Add heptane to the test tubes 1 to 3 up to a filling height of approx. 1 cm (Fig. 2).

3. Add the same amount of paraffin oil (liquid paraffin) to test tubes 4 to 6 (Fig. 3).

Figure 2

Figure 3

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Procedure (1/3)

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1. Add a drop of concentrated sulphuric acid to test tube 1 (Fig. 4), a drop of concentrated nitric acid to test tube 2, a few drops of alkaline potassium permanganate solution to test tube 3 (Fig. 5). Change the pipette each time.

2. Proceed in the same order with test tubes 4 to 6.

Figure 4

Figure 5

Procedure (2/3)

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3. Add a drop of indicator solution to test tubes 1 and 2 as well as 4 and 5 (Fig. 6).

4. Close all test tubes with the stoppers and shake them carefully (Fig. 7 and 8).

Figure 6

Figure 7

Figure 8

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Procedure (3/3)

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Figure 9

5. Carefully heat the test tubes in the flame after removing the rubber stoppers (Fig. 9. The liquids contained must not be heated to boiling point.

Caution: Do not hold the test tube filled with heptane with the opening to the burner flame!

Disposal
Put the contents of the test tubes into the collection container for flammable organic substances.

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Report

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Task 1

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Write down your observations.

Task 2

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Transfer the results to the table.

RG	Content	Result before heating	Result after heating
1	Heptane + sulphuric acid		
2	Heptane + nitric acid		
3	Heptane + potassium permanganate solution		
4	Paraffin + sulphuric acid		
5	Paraffin + nitric acid		
6	Paraffin + potassium permanganate		

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Task 3

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What does it mean for an organic compound to be "saturated"?

An organic compound is said to be saturated if all valence electrons of the carbon atoms are in single bonds. For example, all alkanes are saturated hydrocarbons because all possible compounds are exhausted of either hydrogen or carbon atoms.

An organic compound is called saturated if it has a fatty acid group or an ester on the main carbon chain. This designation comes from the fact that such compounds can no longer undergo any further reactions and are thus "saturated".

Task 4

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The absence of the functional groups makes the alkanes more reactive, as the simple hydrogen bonds are extremely unstable.

Functional groups are more complex and stable and can hardly enter into further reactions due to their special structure and the absence of a dipole.

○ True ○ False

Check

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Task 5

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Drag the words into the correct gaps!

Saturated _____ are usually very stable. Since the _____ are all in simple bonds, no further compounds or atoms can be added to the molecule via _____.
Additionally, the bonds between carbon and hydrogen atoms are much less polar than many of the functional _____ and are therefore less able to undergo reactions.

groups
addition reactions
compounds
valence electrons

Check

Slide	Score / Total
Slide 21: Saturation	0/1
Slide 22: Function groups	0/1
Slide 23: Saturation 2	0/4

Total 0 / 6

Solutions Repeat Export text

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